AS3.12-5899

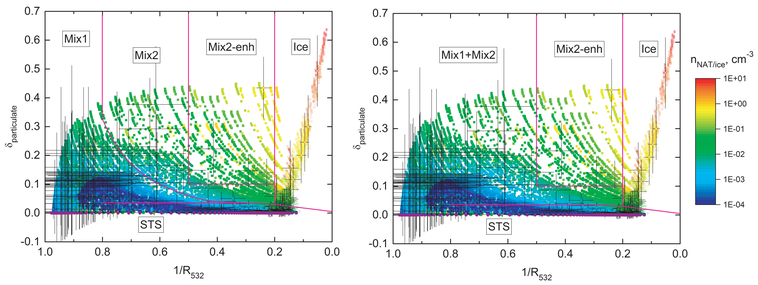
CALIPSO Polar Stratospheric Cloud Observations from 2006-2015

Michael C. Pitts[1] and Lamont R. Poole[2]

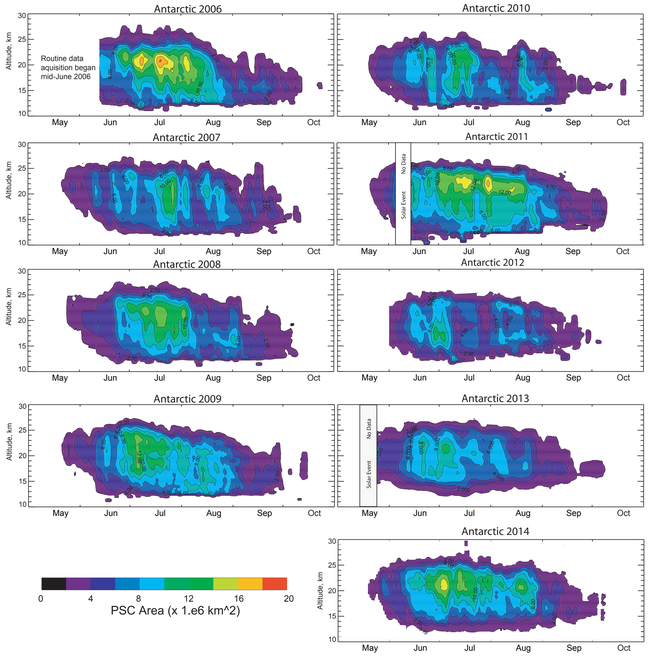
[1]NASA Langley Research Center, Hampton, Virginia USA; [2]Science Systems and Applications, Incorporated, Hampton, Virginia USA

PSC Detection and Composition Classification

- PSCs detected as statistical outliers from background aerosol using nighttime 532-nm scattering ratio (R_{532}) and perpendicular backscatter ($\beta_\perp$)
- Composition classification based on comparison of CALIOP particle depolarization ratio δ_p and inverse scattering ratio $1/R_{532}$ observations with theoretical optical calculations (Pitts et al., 2007-2013)
- Five composition classes in second generation algorithm:
  → STS = supercooled ternary (H_2SO_4-H_2O-HNO_3) solution
  → Mix 1, Mix 2, Mix 2-enh(anced) = external mixtures of liquid (binary H_2SO_4 aerosol or STS) droplets and nitric acid trihydrate (NAT) particles (in increasing number density)
  → Ice, wave ice = H_2O ice (synoptic, mountain-wave-induced)
- When measurement noise is taken into account, there is significant overlap between the Mix 1 and Mix 2 classes. Therefore, in our most recent algorithm we have combined these into one class: Mix1+Mix2



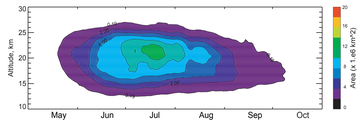
Antarctic PSC Areas: 2006-2014



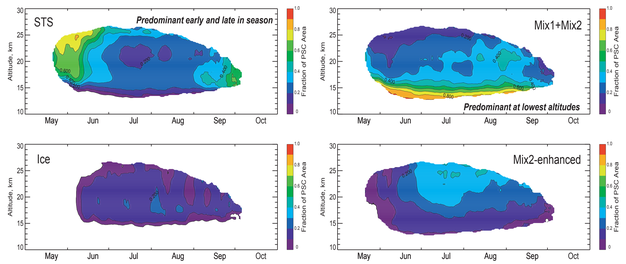
2006-2014 Antarctic Vortex-Average PSC Area

- General evolution of PSC season is similar from year-to-year

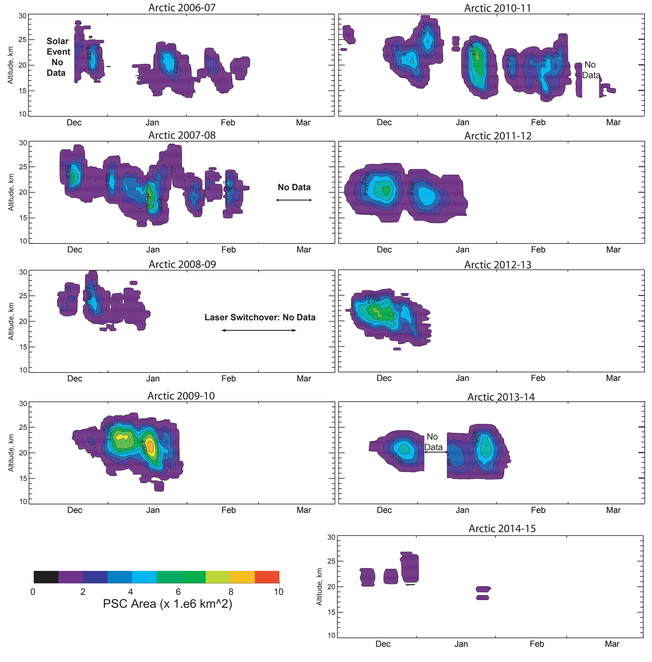
→ Multi-year average is fairly representative



2006-2014 Antarctic Vortex-Average PSC Area by Composition

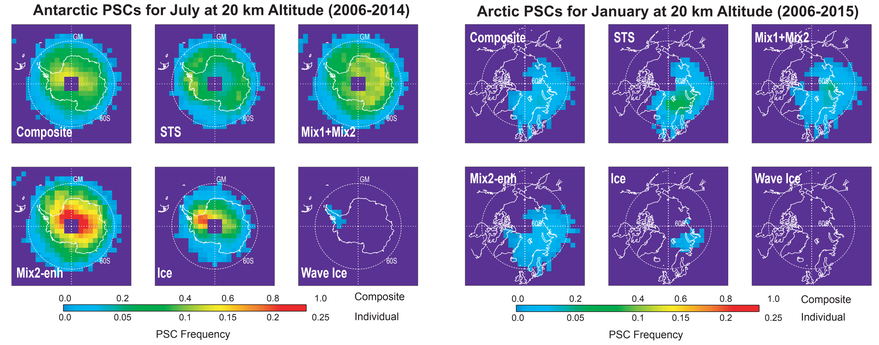


Arctic PSC Areas: 2006-07 to 2014-15



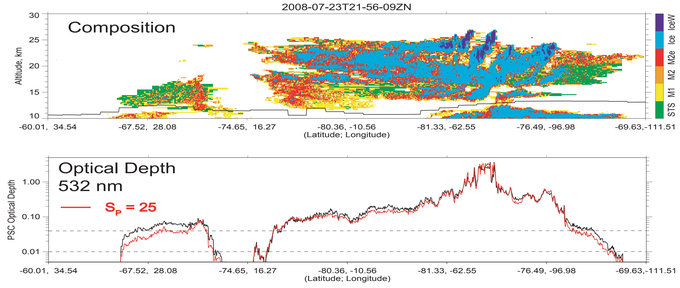
- Arctic PSC occurrence varies dramatically from year to year and is significantly lower overall than in the Antarctic: Multi-year average is not representative

Monthly Average Spatial Distributions



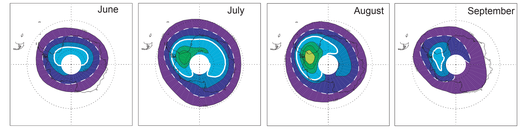
PSC Optical Depth Retrievals

Single Orbit on 23 July 2008



We have developed an approach to calculate PSC optical depth from the CALIOP 532-nm attenuated backscatter measurements using a composition-dependent extinction-to-backscatter ratio. The lower panel shows the retrieved PSC optical depth along a single CALIOP orbit. The dashed lines in the lower panel indicate optical depth values of 0.01 and 0.04 which were used in earlier studies (e.g. Kinne and Toon, 1990; Hicke and Tuck, 2001) as representative of Type 1 (STS and NAT) and Type 2 (ice) PSCs, respectively.

Multi-year Monthly Antarctic PSC Optical Depth Composites



Monthly composites of PSC optical depth based on nine years (2006-2014) of CALIOP Antarctic observations. Large areas of monthly-mean PSC optical depths exceeding 0.04 are present in each month. During July and August monthly means exceed 0.1 in areas near the Antarctic Peninsula, a climatologically favored region for ice PSCs.

Summary

- With measurement uncertainties, there is significant overlap between Mix 1 and Mix2 composition classes
  → Therefore, revised composition classification combines Mix1 and Mix2 into a single class called Mix1+Mix2
- Multi-year averages fairly representative of PSC evolution in Antarctic, but each Arctic winter is unique
- Interesting spatial patterns observed in Antarctic PSC composition
  → [Mix 1 + Mix 2] predominant at lowest altitudes
  → STS predominant early and late in season
  → Frequent maximum in ice PSCs over Antarctic Peninsula
- PSC optical depth retrieved using composition-dependent extinction-to-backscatter ratio
  → optical depth dominated by ice clouds